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(56) Prior art references:

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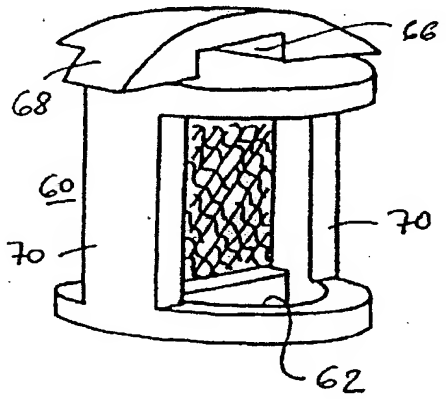
The following information is excerpted from documentation provided by the applicants

A request for examination pursuant to Article 44 PatG (German Patent Act) has been filed.

(54) Hearing aid and filter module therefore

(57) The present invention pertains to a hearing aid with an acoustic output or acoustic receiver device (16; 18) that is integrated into an acoustic input orifice (20; 22) in a hearing aid casing (10), characterized in that a preferably replaceable filter module (60; 88) prevents any fluid and/or foreign matter, particularly cerumen, from building up in the device by entering through the acoustic input orifice (20; 22). The filter module is equipped with a planar, membrane-like and/or mesh-like filter element (72; 82; 90) which is accommodated in the hearing aid casing adjacent to the acoustic input orifice and at an angle to such orifice in such a way that it is either perpendicular to a center wave direction (26) that is generated or received by the acoustic output or receiver device (as the case may be); or at an angle to an acoustic channel (17; 19); or at the reference position determined by the orifice itself.



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Description

[0001] The present invention pertains to a hearing aid pursuant to the generic term for claim 1, a filter module for a hearing aid of the related art, as well as the use of such filter module.

[0002] Foreign matter in hearing aids occasioned by (a) external or bodily fluids such as sweat or the like and/or (b) any foreign matter (particularly cerumen) that might build up in the device constitute a serious problem in the field of hearing aid technology. This problem has a decisive impact on hearing aid servicing intervals and, ultimately, hearing aid service life. Hence, the cerumen generated in the user's ears poses a major technical problem since the cerumen can build up in the hearing aid by entering through the acoustic input orifice (used for the microphone placed behind it) or through the acoustic output orifice (used for a speaker or similar acoustic output device) in the hearing aid casing. Cerumen has two adverse effects on the hearing aid: owing to its consistency, it can clog the aforementioned orifices, thus degrading the technical efficacy of the hearing aid; and the cerumen can permanently disable the acoustic input and output devices in the hearing aid.

[0003] Numerous inventions that are known from the state of the art prevent foreign matter from building up in hearing aids through the use of appropriate filter modules. In the following, these inventions will be elucidated on the basis of Fig. 10-18 and a description of hearing aid design principles and the attendant spatial configuration options.

[0004] Fig. 10 shows a hearing aid that is known from the state of the art. This type of hearing aid is known as an in-ear device and has a casing (10) that accommodates (a) an electronics module 14 that is connected to a power source (battery 12) and is used for boosting and signal processing purposes; (b) an acoustic input device (microphone 16) that is connected to the electronics module 14; and (c) an acoustic output device (speaker) 18. One of the output orifices 20 in the casing 10 for the acoustic input device 16, as well as the control elements (not shown in Fig. 10), faces outward when the hearing aid is worn (i.e. the aforementioned elements are outside the user's ear), and there is an acoustic output orifice 22 in the casing for the acoustic output device 18 that allows for compact signal conduction to the user's auditory canal by virtue of the individual form of the casing 10.

[0005] This design principle and the attendant spatial configuration make the acoustic output orifices of in-ear hearing aids particularly vulnerable to the cerumen generated by the human ear. Fig. 11 provides a cross-sectional view of the left side (inner ear side) of the configuration (Fig. 10) of a filter module 24 used for an acoustic output orifice 22 in a casing 10. This filter module mainly consists of a hollow cylindrical body outfitted with mesh that is installed at a 90 degree angle to the central pathway (dotted line 26) of the emitted sound.

[0006] Fig. 12 shows a known alternative realization of a hearing aid, referred to as a behind the ear device. In the interest of employing uniform terminology, assemblies whose functions overlap have been given the designations that are used in Fig. 10. Here, too, a casing 10 worn behind the ear accommodates an acoustic receiver 16 that is linked to an acoustic output orifice via an acoustic channel (tube) 17. In addition, an acoustic output device 18 is linked to the user's ear via a dedicated tubular acoustic channel and also acts as a link to an earpiece (not shown) via an angle component that is integrated into the casing 10.

[0007] A side by side comparison of Fig. 10 and 12 (and of the generic hearing aid realizations elucidated by such comparison) shows that the design of behind the ear devices makes them far less prone to foreign-matter buildup, owing to the greater distance (80 mm) from the acoustic output device to the acoustic egress point at the end of the angle component 28. Here, cerumen that detaches from the user's ear must first traverse the aforementioned 80 mm distance to the acoustic output device before the cerumen can cause any functional degradation. However, this configuration is still particularly vulnerable to (a) liquids building up in the hearing aid and causing damage, especially when it comes to external fluids stemming from activities such as swimming and (b) foreign matter building up in the hearing aid and impairing microphone 16 functionality (Fig. 2).

[0008] Although in-ear devices are becoming increasingly popular owing to the fact that they provide better acoustic performance, these devices are also in need of improvement when it comes to preventing cerumen buildup in the hearing aid. This shortcoming is reflected by the generally known fact that in-ear devices exhibit a higher failure rate than their behind the ear counterparts. [0009] Fig. 13 through 18 illustrate designs known from the state of the art that are intended to prevent the buildup of foreign matter, particularly cerumen, in hearing aids. The cylindrical element 30 shown in Fig. 16, whose slanted acoustically permeable mesh is the main element of a filter module 24, is essentially identical to the solution described in connection with Fig. 11, i.e. realization of a perforated planar carrier at an angle to the center of the pathway of the emitted sound with a view to preventing any foreign matter from building up in the device. As can be seen from the cross-sectional view in Fig. 16, this approach is relatively ineffectual, particularly for long-term hearing aid wear, owing to the fact that cerumen accumulates inside the cylindrical element 30 and clogs the entire filter module 24. This in turn necessitates frequent replacement or servicing, and in extreme cases such clogging scenarios can arise within a matter of hours.

[0010] The configuration illustrated in Fig. 15 is equally unsatisfactory. In this case, the acoustic output orifice of the hearing aid (as is also shown in the outer area of the upper half of Fig. 16 (the lower area faces downward)) is covered by a snap-on cap 36 with perforations 34, with the result that the cap covers the output orifice of its acoustic channel 38 whose acoustic flow moves upward when the device is used with a speaker. In this case, the sound is only emitted through the perforations 34. This design is also flawed in that the more cerumen the cap 36 prevents from building up in the auditory channel, the greater the risk that the perforations 34 will become clogged and have to be cleaned.

[0011] Fig. 17 and 18 illustrate a variant of the design concept of covering the acoustic channel 38 with a cap. Here, the sound emerging from the acoustic channel 38 is directed to a cover 40 over the filter module shown and is then directed to the auditory canal by an annular slit 34 in the transitional area between the end of the acoustic channel 38 and the cover 40. The fact that the annular slit 42 is covered by an overhanging ring flange 44 on the cover 40 greatly reduces the risk of cerumen building up in the device.

However, this design is also prone to clogging, which means that the realization of acoustic properties in accordance with Fig. 17 and 18 may well be problematic.

[0012] In addition, as is shown in Fig. 13 and 14, a known filter module marketed by the U.S. supplier Knowles is outfitted with a die 50 (controlled by a prestressed spiral spring 48) that cleans the orifice on the ear side 46 by pushing a cleaning mechanism (in an upwards direction in Fig. 14) into the orifice 46 and expelling the accumulated cerumen.

[0013] Apart from the design and manufacturing expense involved in the solutions shown in Fig. 13 and 14, these solutions also pose the problem that if cerumen penetrates relatively deeply, it can completely obstruct the acoustic channel (i.e. the areas around the die 50) and can impair die mobility.

[0014] Hence, the goal of the present invention is to provide a hearing aid of the related art that provides enhanced protection against the entry of solid or liquid foreign matter, and which above all provides a filter module that reduces the risk of malfunction occasioned by cerumen buildup, with a view to prolonging hearing aid service life and simplifying servicing procedures.

[0015] This goal may be achieved by means of (a) a hearing aid with characteristics according to claim 1 and (b) a filter module with the characteristics of claim 9, which is an independent claim. Beneficial embodiments of the present invention are described in the subsidiary claims, which are based on the main claim and are also intended for an analogous application in the filter module according to claim 9.

[0016] The present invention allows for the deployment of a filter module with an at least partially sloped filter element, an increased conductive sound inlet channel, as well as a reduced risk of filter element clogging and foreign matter build-up owing to the slope and the increased conductive area. "Sloped" within the context of the present invention means any configuration that is realized in such a way as to differ from a zero degree angle (reference plane for a planar filter element), whereby angles ranging from 45 to 90 degrees (i.e. a planar filter element deployed along the center of the acoustic pathway) have been found to be particularly advantageous and preferable for practical applications.

[0017] The present invention also provides an optimally voluminous acoustic input surface (which is increased by the slope) in conjunction with optimally small perforations (to protect against foreign-matter buildup) and inlet orifices, owing to the use of a membrane and mesh. The aforementioned applies in particular when a water and/or grease repellent membrane is used, since either of these modalities can provide highly effective protection against foreign-matter buildup without degrading acoustic transmission properties. (The geometric ratios in the state of the art (cf. for example Fig. 16) ratios generally do not allow for the use of a membrane since the resulting narrow width would degrade acoustic properties to the point where they would be inadequate for acoustic transmission.)

[0018] The present invention also allows for an alternative to the aforementioned use of a membrane, viz. the use of a mesh-like filter element which would be particularly inexpensive to manufacture from a technical standpoint in that it would be manufactured in conjunction with the support elements of the filter module either in a conjoint manufacturing process (e.g. via spray casting of the mesh and other components);

or an appropriate mesh element would be sprayed in an appropriate manner with a conventional plastic material that is normally used for the filter module. Accordingly, within the context of the present invention "mesh like" also means a filter element containing pores or an opening that is manufactured using a sintering process.

[0019] In this regard, one of the most advantageous embodiments of the present invention is that an extremely fine mesh could be realized through the appropriate use of an embodiment of conventional punches in such a way as to create retention volume for accumulations of foreign matter. This solution would have a positive effect on the operating cycle of hearing aids thus protected.

[0020] The present invention would provide protection for in-ear and behind the ear hearing aids in such a way as to greatly improve the protection and handling properties of such devices relative to the solutions described above, and at the same time would also simplify the manufacturing process and thus result in potentially lower end user costs.

[0021] Additional benefits, properties and particularities of the present invention can be found in the descriptions below of preferred embodiments of the invention, and are also identified in the following illustrations:

[0022] Fig. 1: a lateral view of a filter module for a hearing aid according to the initial preferred embodiment of the present invention

[0023] Fig. 2: A lateral, partially cross-sectional view of the configuration according to Fig. 1

[0024] Fig. 3, 4: Longitudinal view of the configuration (according to Fig. 1 and 2) of an embodiment in an acoustic channel, whereby Fig. 3 is a variant hereupon.

[0025] Fig. 5: a variant of the embodiment shown in Fig. 1 and 2, with a mesh-like filter element

[0025] Fig. 6: a detail view of the embodiment shown in Fig. 5.

[0025] Fig. 7: a detail view of the mesh element in the embodiment illustrated in Fig. 5

[0028] Fig. 8: a second embodiment of the present invention as a realization in a behind the ear hearing aid

[0025] Fig. 9: a detail view of the filter module used in Fig. 8

[0030] Fig. 10: a cross-sectional view of an in-ear hearing aid that illustrates the relevant design principals and functionalities

[0031] Fig. 11: a detail view of the auditory canal side of the end section of the device pursuant to Fig. 10, for purposes of elucidating the deployment of the filter module.

[0032] Fig. 12: cross-sectional view for purposes of elucidating the architecture of a behind the ear hearing aid

[0033] Fig. 13: a partial cross-sectional view of a filter module known from the state of the art

[0034] Fig. 14: a longitudinal view of the configuration according to Fig. 13

[0035] Fig. 15: a cross-sectional view of an additional filter module that is known from the state of the art

[0036] Fig. 16: a cross-sectional view of yet another filter module that is known from the state of the art

[0037] Fig. 17: a cross-sectional view of yet another filter module that is known from the state of the art

[0038] Fig. 18: a cross-sectional view along line A-A in Fig. 17.

[0039] As shown in Fig. 1, a cylindrical filter module 60 (in lieu of module 24) can be used in an in-ear hearing aid according to Fig. 10 and 11. This filter prevents foreign matter and fluid from building up in the device and is a replaceable component.

[0040] When used in conjunction with an acoustic output device (speaker), the unit shown in Fig. 1 and 2 comprises a circular base 62 that forms an acoustic output orifice and opposite this base an output section 64 (which is clearly depicted in Fig. 3 and 4), in addition to a cover section 68 which is concave arched towards the end, forming an output orifice 66.

[0041] The circular base 62 and the output section 64 are linked by longitudinal, one-constituent connecting sections 70 that face each other. These sections (cf. in particular Fig. 2) accommodate and delimit a membrane element at the center of the filter module 62, whereby the filter element extends vertically to the base 62 and contains an acoustic input orifice.

[0042] Fig. 3 and 4 (and arrows 74-77, which illustrate the sequence of the acoustic flow for a scenario in which the unit shown is operated in conjunction with an acoustic output device (speaker) via an acoustic channel 78) shows the main functionalities of the filter module according to the present invention, in the form of a filter element and acoustic channeling mechanism. As a comparison of Fig. 3 and 4 also shows, the configuration in Fig. 4 is identical to that in Fig. 1 and 2 whereby acoustic output occurs bilaterally via the orifice 66 along the path indicated by arrow 77, while at the same time the cover 68' shown in Fig. 3 is open on one side only so as to provide additional protection against the risk of foreign matter build-up.

[0043] The sound enters the filter module 60 via the base, is then directed through the vertical filter element membrane 72, and is then directed again in such a way that it exits the output area 64 through a horizontal egress.

[0044] There is no major impediment to efficacious acoustic flow in this configuration, thus ruling out any problem of this kind. At the same time, this configuration also greatly reduces the risk of cerumen build-up, primarily because any cerumen that builds up in the area on the egress side 80 of the filter module will build up not on the membrane, but rather on the base, thus eliminating the risk of membrane clogging. In addition, the longitudinal deployment of the membrane element 72 allows for the deployment of a membrane material such as Teflon in such a way as to have no negative impact whatsoever on the acoustic properties of the hearing aid.

[0045] Figure 5 (which is similar to the view and architecture shown in Fig. 1 and 2) illustrates an alternative realization of the filter element in the filter module shown 60'. The only difference in the architecture here is that in lieu of a membrane 72, a single piece of mesh 82 composed (as is the case with the other filter module and as described in the realization example) of plastic, metal, sintered or similar material is spray-cast around the base 62, egress area 64, and connecting part 70.

[0046] The mesh 82 contains a series of perforations 84 which (see Fig. 6) are realized with an enlargement of section B in Fig. 5, as a set of partially overlapping reciprocally offset and facing forms using appropriate punches during the spray casting process. In other words, each perforation 84 consists of two overlapping forms 86, which (as can be seen in Fig. 7) have a circular profile in the realization example shown.

[0047] Needless to say, since the mesh 82 described herein could be realized using any punch diameter and/or profile, optimally precise and relatively inexpensive mesh could be manufactured for specific applications.

[0048] Fig. 8 shows an additional embodiment of the present invention for a behind the ear hearing aid based on the architecture described above. Here, both the output end of one of the acoustic output device's 18 acoustic channels (tube) 19, as well as the input end of one of the acoustic receiver's 16 acoustic channels 17, is outfitted with a filter module 88 which, in accordance with the present invention, is deployed at an angle. Here too, 26 indicates that the acoustic signal is propagated in the center. Also shown is the manner in which a membrane 90 used in a filter module 88 is angled relative to a realization in the channel 17, 19 cross-section level (see Fig. 16). This is advantageous in that it enlarges the conductive surface and is thus the first invention to enable membrane material replacement. The end of the filter module 88 membrane surface 90 is held in place by a removable cylindrical insert (see Fig. 9).

[0049] The realizations of the present invention are by no means limited to the examples shown here. In fact, the filter module element according to the invention can be fixed in place in any way desired, i.e. either integrally or by spraying an appropriate preselected part with the same plastic material that is used of the filter module. Moreover, the filter module does not necessarily have to be planar, and can instead by partially or wholly bowed or creased.

[0050] In addition to the aforementioned lower series production costs, the present invention would also shorten the time-consuming cleaning and servicing processes that are now required for dirty hearing aids by allowing for effortless replacement of the components in accordance with the invention. This would result in substantial optimization of the everyday use of hearing aids.

Patent claims

1. Hearing aid with an acoustic output or acoustic receiver device (16; 18) that is integrated into an acoustic input orifice (20; 22) in a hearing aid casing (10), **characterized in that** a preferably replaceable filter module (60; 88) prevents any fluid and/or foreign matter, particularly cerumen, from building up in the device by entering through the acoustic input orifice (20; 22). The filter module is equipped with a planar, membrane-like and/or mesh-like filter element (72; 82; 90) which is accommodated in the hearing aid casing adjacent to the acoustic input orifice and at an angle to such orifice in such a way that it is either perpendicular to a center wave direction (26) that is generated or received by the acoustic output or receiver device (as the case may be); or at an angle to an acoustic channel (17; 19); or at the reference position determined by the orifice itself.

2. Hearing aid according to claim 1, characterized in that an angle between the reference level and a level determined by a surface area of the filter element is a minimum of 30 degrees and in particular approximately 90 degrees.

3. Hearing aid according to claims 1 or 2, characterized in that the acoustic input orifice formed by the filter module is dimensioned in such a way that a greater than zero degree and preferably greater than 45 degree angle is realized between an acoustic input orifice in the filter module and an acoustic output flow from the filter module.

4. Hearing aid according to claims 1-3, characterized in that the filter element (82) is realized in a support surface via a series of adjacent perforations (84). Such perforations are preferably to be spray cast using a plastic material, and likewise preferably, the support surface is to be formed either as a section of the filter module or as an element that can be removed and replaced.

5. Hearing aid according to claims 1-4, characterized in that the filter element is prefabricated and is integrated as a filter module in a preferably removable constituent of the hearing aid casing, or in a hearing aid connector, particularly an angle piece (28) via spray casting.

6. Component according to claim 4, characterized in that the perforations are spray cast and are realized by a series of reciprocally oriented, preferably paired and defined facing punches, whose contact area coverage determines perforation width.

7. Hearing aid according to claim 6, characterized in that the punches create punch holes and/or forms whose hole diameters vary.

8. Hearing aid according to claim 1, 2, 3, 4, 5, 6 or 7, characterized in that the filter element repels aqueous and/or greasy material, and particularly that the filter element repels aqueous and/or greasy material and is permeable to air.

9. A hearing aid whose filter module is equipped with one acoustic input orifice and one acoustic output orifice, and between such orifices a planar membrane and/or mesh like filter element (72, 82) is provided in such a way that a surface section of the filter element is at an angle to a reference level that is determined by the acoustic input opening.

10. Use of a filter module according to claim 9, preferably as a removable component that prevents liquid or cerumen from building up in a behind the ear or in-ear hearing aid.

(see the drawings on the following four pages).

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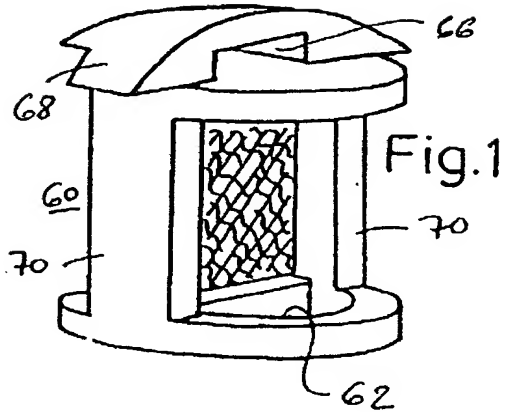


Fig.1

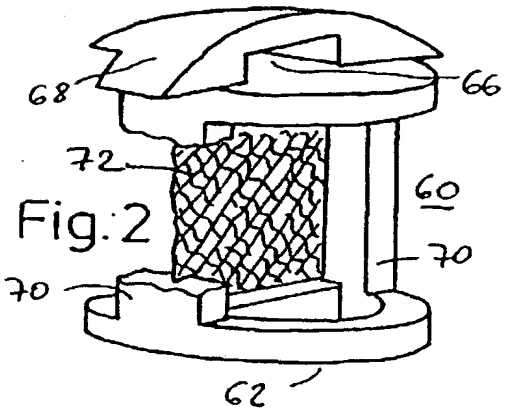


Fig.2

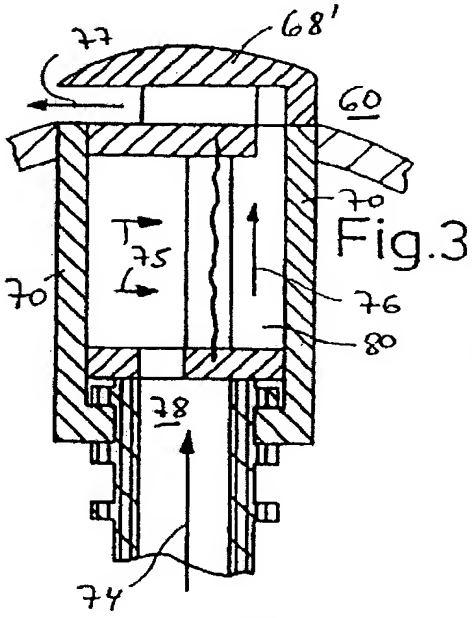


Fig.3

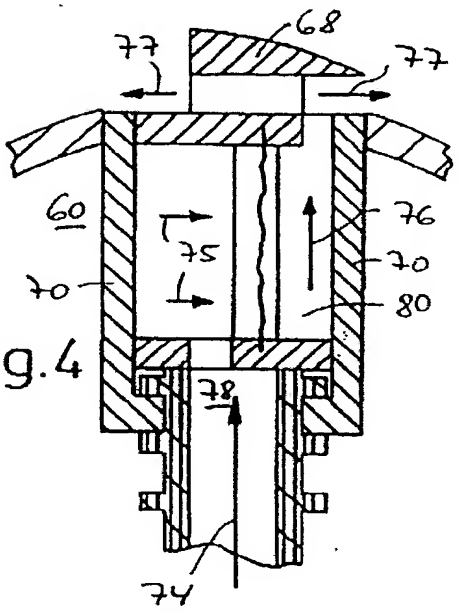


Fig.4

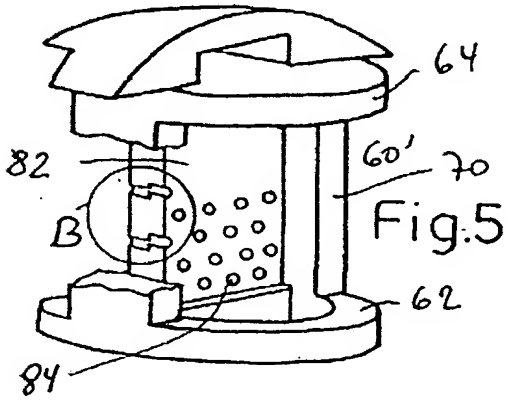
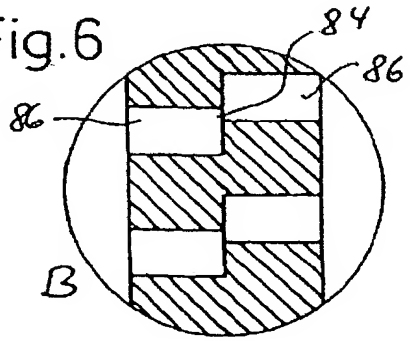


Fig.5

Fig.6



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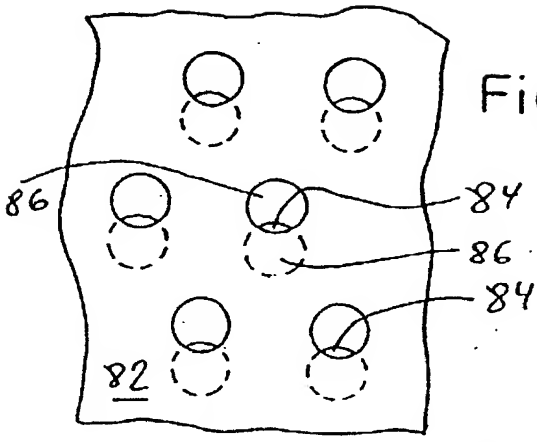

Fig.7

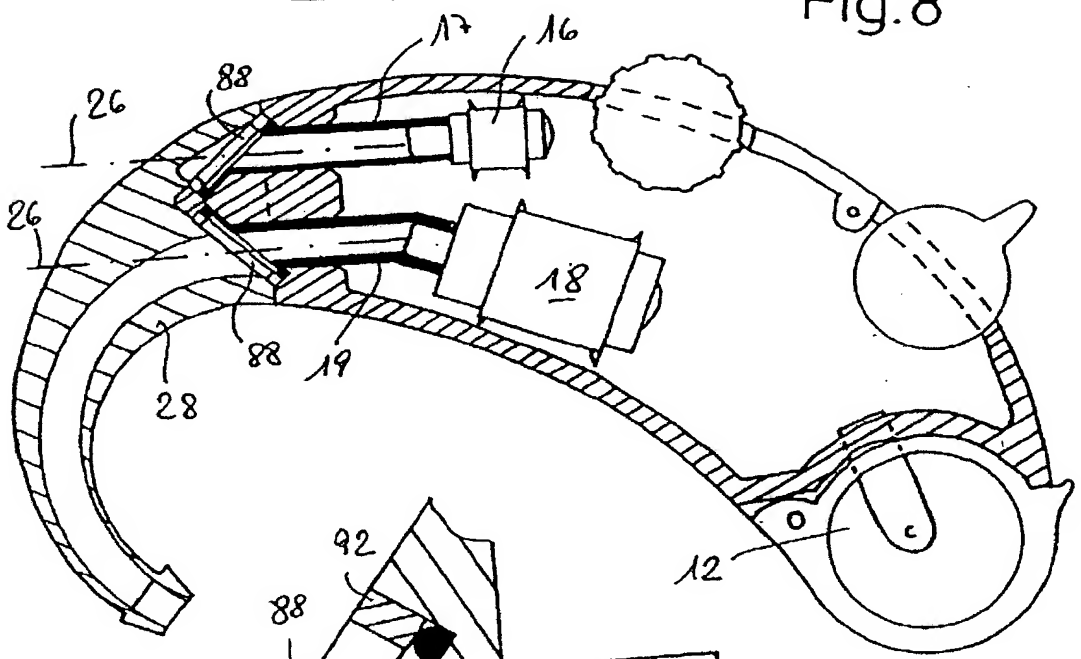

Fig.8

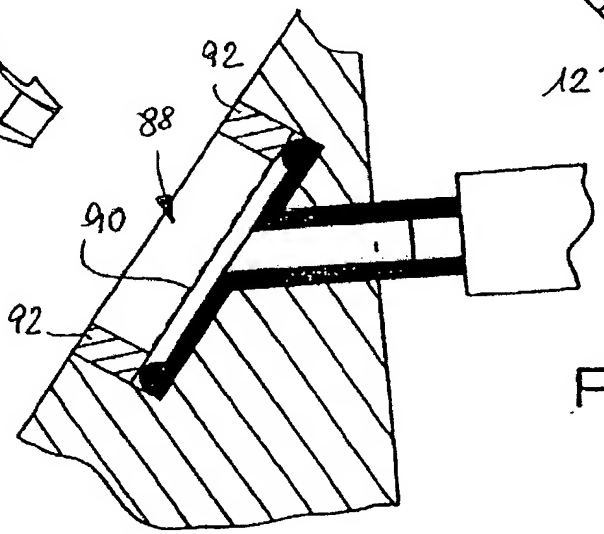

Fig.9

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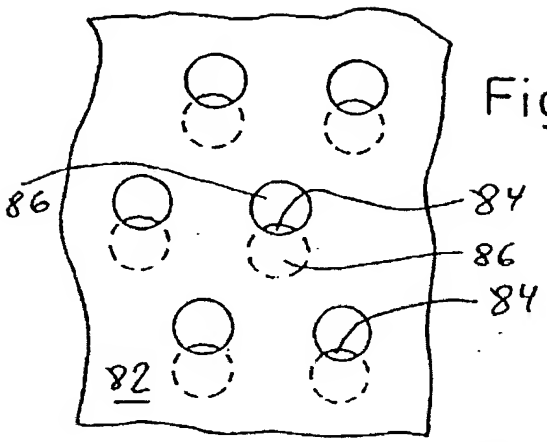

Fig.7

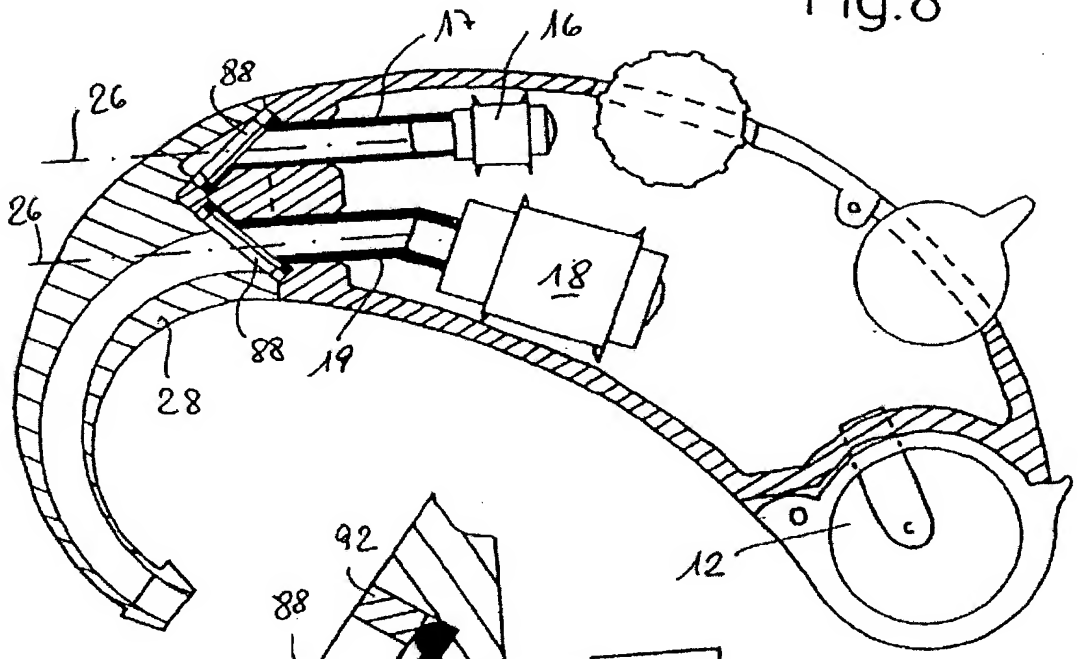

Fig.8

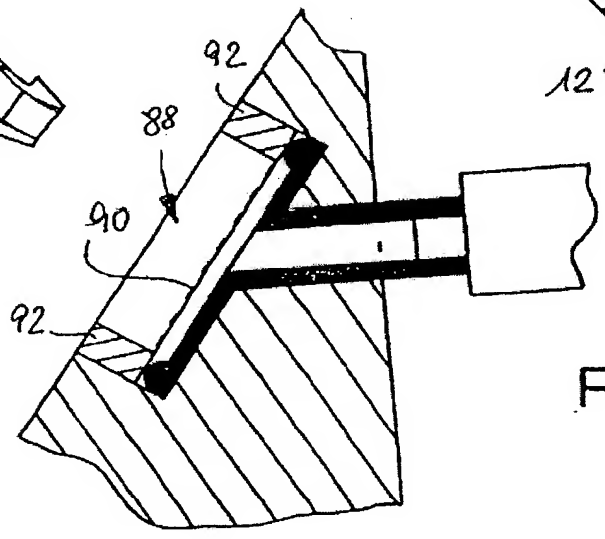

Fig.9

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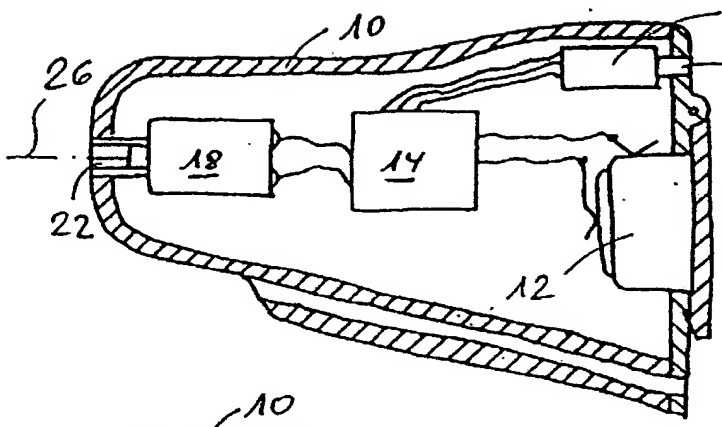

Fig.10

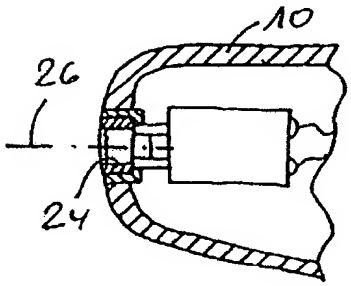

Fig.11

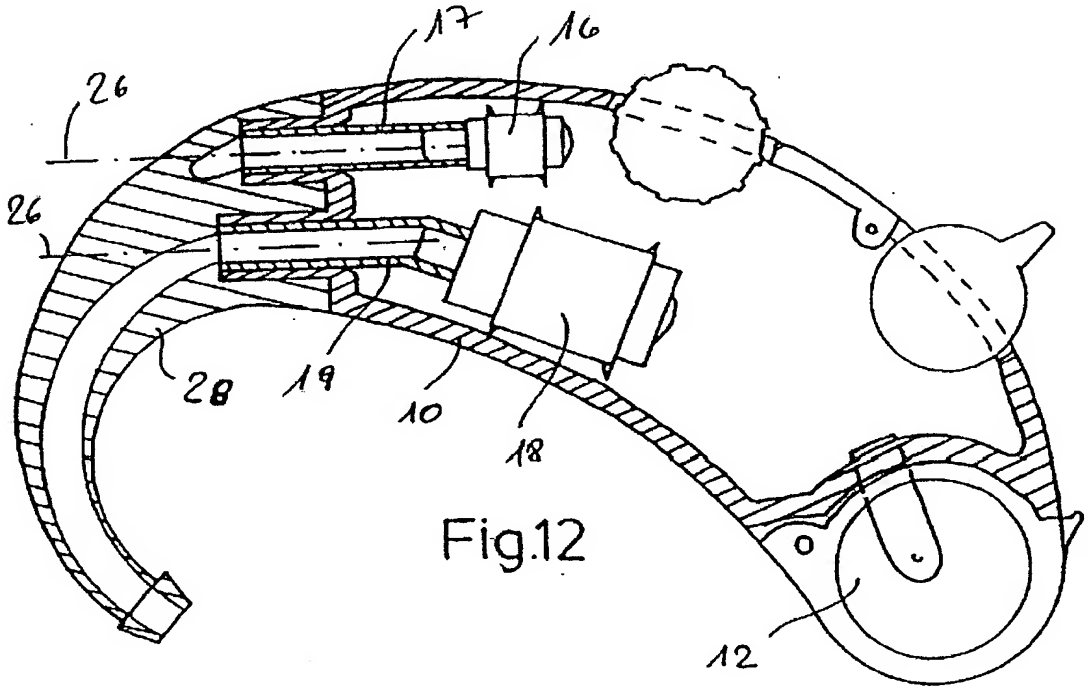

Fig.12

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Fig.13

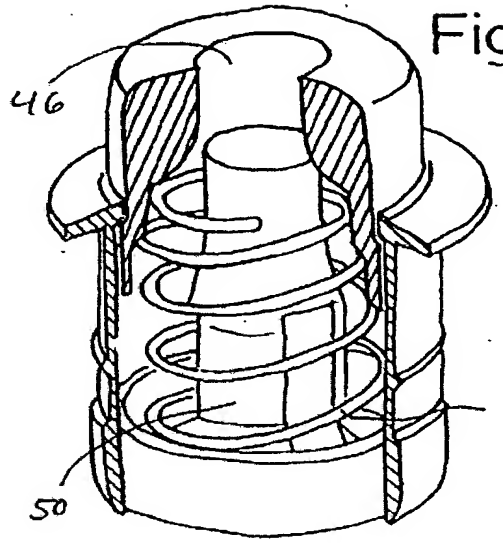


Fig.14

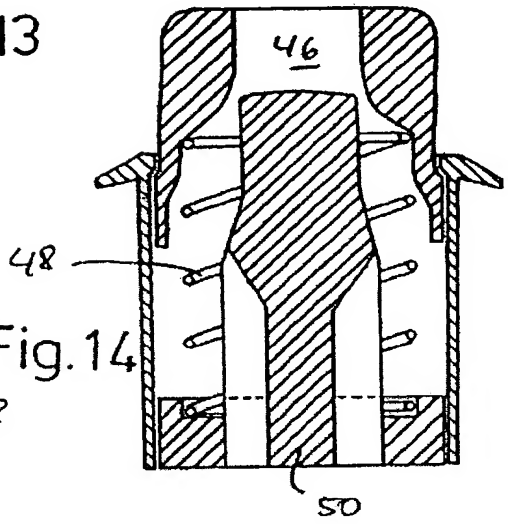
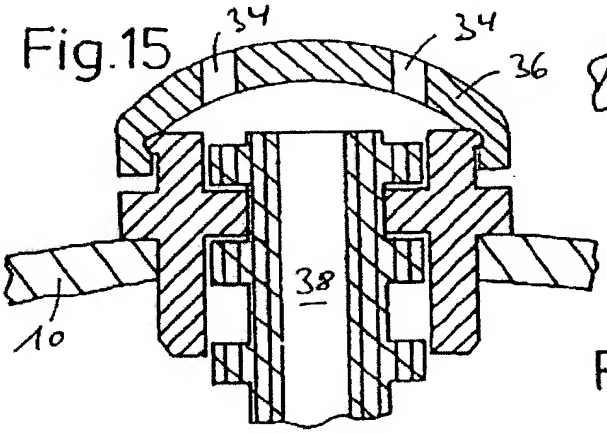


Fig.15



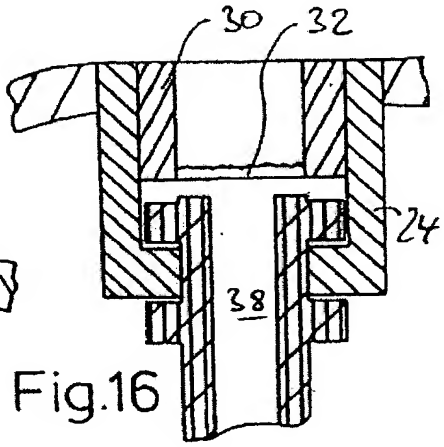


Fig.16

Fig.17

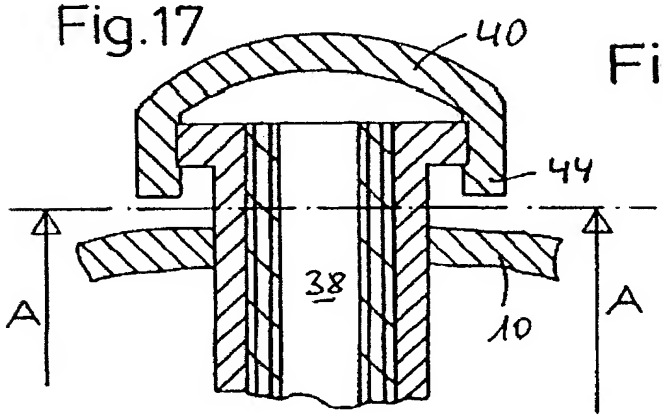


Fig.18